Kachemak Bay Research Reserve

KACHEMAK BAY
RESEARCH RESERVE
ALASKA DEPARTMENT OF FISH AND GAME
2181 KACHEMAK DRIVE
HOMER, ALASKA 99603

The Spatial Distribution of Bull Kelp (*Nereocystis leutkeana*) in Kachemak Bay

by G. Carl Schoch and Heloise Chenolet

(Contact: carl_schoch@fishgame.state.ak.us)

Abstract

In August 2000, the spatial distribution of *Nereocystis leutkeana* kelp beds was mapped in the Kachemak Bay Research Reserve. Low altitude aerial photos were taken using a medium-format camera and a light fixed-wing aircraft to produce oblique photo imagery. These images were geometrically corrected and the kelp beds delineated. The polygon data were entered into a GIS so that estimates of areal extent can be compared among beds and among years. In 2000, over 30.6 km² of kelp forest were mapped in the bay. Preliminary estimates indicate a >10% decline in surface area between 2000 and 2001. This was mostly due to the inundation of rocky habitat by sand over a shallow subtidal bench near the Homer Spit. The variability of each kelp bed area and density will be tracked over time as an indicator of change and kelp community health.

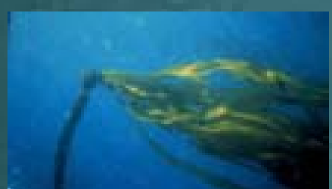

Figure 1. The sporophyte life stage of *Nereocystis luetkeana*.

Figure 2. The geographic distribution of *Nereocystis luetkeana*.

Introduction

Bull kelp (*Nereocystis luetkeana*) has a complex life cycle with a planktonic spore, a filamentous microalgal stage, and a reproductive macroalgae stage (Fig. 1). This alga occurs in kelp forests along the Pacific coast from Point Conception, California to the Eastern Aleutian Islands, Alaska and is the dominant surface-canopy kelp north of Santa Cruz, California (Fig. 2). Its hydrodynamic shape makes bull kelp especially well suited to high energy, open coast environments. *Nereocystis* is predominantly an annual, although mature plants in Kachemak Bay have been seen to persist for over 2 years. In Kachemak Bay, growth rates of up to 10 cm per day have been observed in young plants (Chenolet et al., 2001), and the mature surface canopy reaches its maximum extent in July through October.

Figure 3. We have established long term monitoring transects in kelp beds throughout Kachemak Bay. The data provided by these sites will help us understand the temporal dynamics of this complex habitat.

Figure 4. *Nereocystis* is among the largest and fastest growing of the marine algae. Growth rates of up to 25cm/day have been recorded. Older individuals are known to obtain lengths over 40 meters during their annual growing season (O'Clair and Lindstrom, 2001).

The areal extent of the kelp canopy changes from year to year. Annual fluctuations in canopy cover are thought to be the result of a complex combination of physical, chemical, and biological factors (Fig. 3). Water motion, temperature, salinity, nutrients, light intensity, available habitat, and herbivory have all been associated with kelp canopy health and development (Fig. 4). However, adjacent kelp beds that are exposed to similar physical factors frequently produce vastly different canopy sizes, revealing the complexity of this dynamic habitat (Duggins et al., 2001). Also, kelp beds are known to have tight trophic interactions. Sea urchins graze on holdfasts that secure the kelp to rocky substrates and sea otters prey upon the urchins. The relationships of these individual factors are not fully understood and continue to be the subject of ongoing research investigations in Kachemak Bay and throughout the North Pacific.

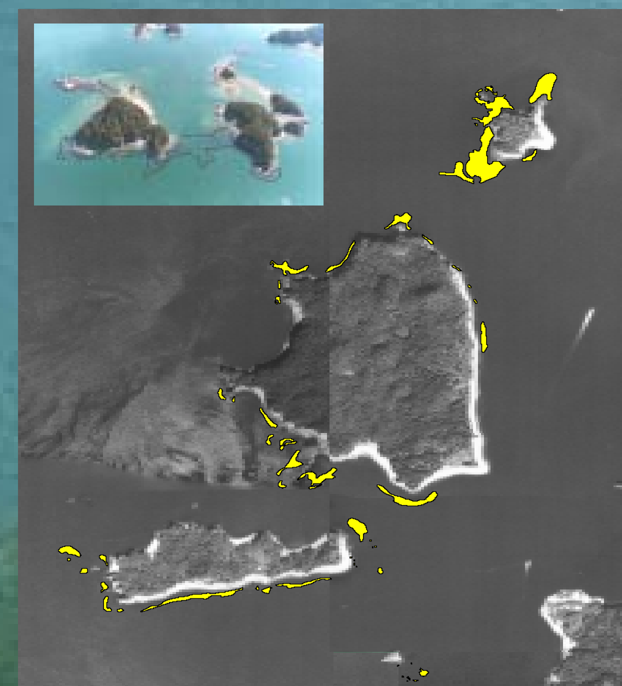

Figure 5. Detail of kelp canopy distribution superimposed on a vertical digital orthophoto of Yukon and Hesketh Islands on the south side of Kachemak Bay (Inset: oblique aerial photo of kelp canopies in the Herring Islands on the south side of Kachemak Bay).

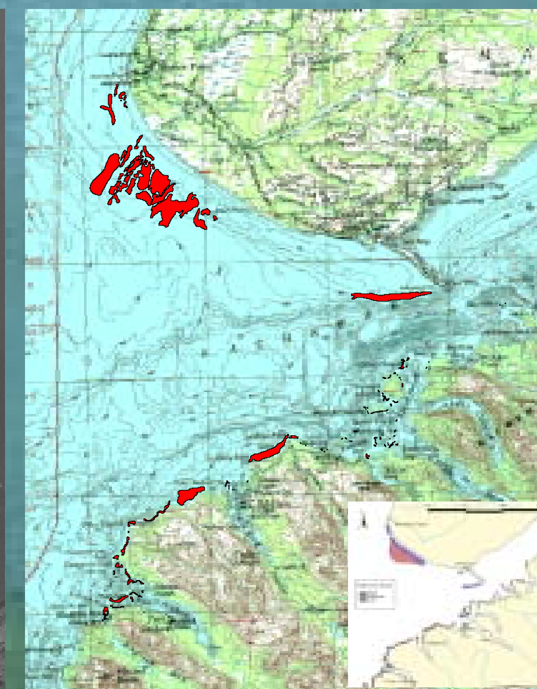

Figure 6. Quantitative spatial distribution of *Nereocystis* canopies in Kachemak Bay (Inset: qualitative canopy density of Nereocystis in Kachemak Bay on August 30, 2000.

Methods

A Hasselblad 501 medium format camera was used with a 70mm lens set at stop f-4, 1/250 speed, using 200 ASA film. The aerial photography flights were made on August 30, 2000 from 9-11 am. Continuous sequential vertical and oblique aerial photos with 20-30% overlap were taken of the kelp beds from Anchor Point to Homer on the north side of the bay, and from Halibut Cove to Point Adam on the south side of the bay. Over 120 images were taken to capture the kelp canopies in the bay. The water penetration was approximately 2-3 meters, depending on turbidity.

Base-line maps from this coastal kelp survey were produced from the photo images. Kelp canopies on each image were delineated with a polygon and the entire image was then scanned at 600 dpi. ERDAS Imagine was used to geometrically rectify each image. Digital orthophoto quads (1 meter pixels) from the Natural Resource Conservation Service in Palmer, Alaska were used as basemaps to register each scanned image. Once registered, the canopy polygons were digitally traced on-screen using the ERDAS Imagine Vector Module. All canopies consisting of more than two plants were digitized. The canopy map was set to the Alaska Albers Conical Equal Area projection (Fig. 5).

Results

The total area of delineated kelp canopy in the Kachemak Bay Research Reserve in 2000 was 30.6 km². This includes the area of the bay from Anchor Point to Point Pogibshi. An additional 17 km² of kelp canopy occurs further out the bay between Point Pogibshi and Point Adam (Fig. 6). The most striking aspect of the spatial distribution, is that the largest kelp beds occur on the north side of the bay. The low slope angle of the rocky habitat in this area, where depths range from 10 and 20 meters, allows a greater surface area of habitat to be available for successful spore recruitment. Interestingly this population may represent the furthest north kelp bed on the east side of Cook Inlet. Other large kelp beds flank the entrance to Seldovia Bay, and a solitary large bed occurs near the end of the Homer Spit. There were no large beds observed in the inner bay beyond the Homer Spit.

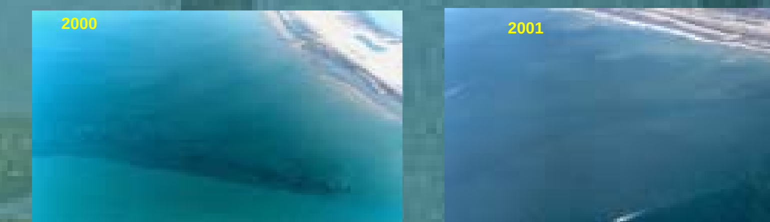

Figure 7. The left photo shows a portion of the large kelp bed off the Homer Spit in 2000. Note the distinctive hourglass fishing basin on the spit at the right of the photo. The right photo was taken in the same area in 2001. Subsequent dives found that up to 2 feet of sand had migrated over the rocky bottom. Our aerial surveys will track the progression of kelp bed recovery as the habitat emerges from under the layer of sand.

Conclusions

The aerial survey, mapping and GIS display of the kelp beds in Kachemak Bay will provide scientists and managers with the first accurate inventory and spatial distribution maps of the Bull Kelp *Nereocystis leutkeana*. Kelp forests are known to provide habitat for a complex array of other marine organisms including rockfish, sea urchins, otters, octopuses, snails, diving seabirds, and a large number of understory algae. There is a well known link between increased secondary production and the proximity of kelp forests (Duggins et al., 1989). Permitting and management of kelp harvesting must consider the long term implications to ecosystem stability. We have established long term monitoring transects in kelp beds throughout Kachemak Bay. The data provided by these sites will help us understand the temporal and spatial dynamics of this complex habitat (Fig. 7 & 8).

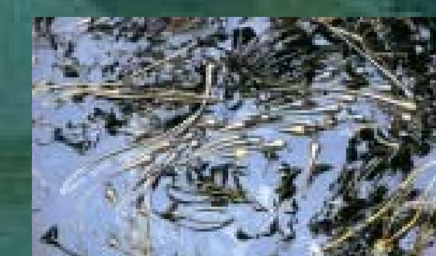

Figure 8. The beds appear to be more robust on the south side of the bay, and more so near the bay entrance around Port Graham. These kelp beds were all very dense, forming thick mats on the surface at low tide.

Acknowledgements

This study was funded by a grant from the U.S. Fish and Wildlife Foundation under Agreement #701810J306. I thank the Program Manager, John Delapp, Jose DeCreft for piloting the aircraft under less than ideal conditions, and Joel Cusick of the National Park Service for re-projecting the digital orthophoto basemaps.

References

Chenelot, H., G.C. Schoch, B. Konar, 2001. Role of Salinity and Turbidity on the Growth of *Nereocystis luetkeana*. Proceedings: W. Soc. Nat., Ventura, CA.

Dayton, P.K., 1985. Ecology of kelp communities. Ann Rev Ecol Syst 16:215-245

Duggins, D., J.E. Eckman, C.E. Siddon, and T. Klinger, 2001. Interactive roles of mesograzers and current flow in survival of kelps. Marine Ecology Progress Series 223:143-155.

Duggins, D. O., C. A. Simenstad, J. A. Estes, 1989. Magnification of secondary production by kelp detritus in coastal marine ecosystems. Science 245:170-173

O'Clair, R.M., S. C. Lindstrom, 2000. North Pacific Seaweeds. Plant Press, Auke Bay, AK

Van Wagen, R.F., 1996. Washington Coastal Kelp Resources. A report to the Olympic Coast National Marine Sanctuary.